

REMARKS

Applicants thank the Examiner for the very thorough consideration given the present application. Claims 1-6 are currently pending in this application. None of the claims have been amended. Accordingly, no new matter has been added.

In view of the remarks herein, Applicants respectfully request that the Examiner withdraw all outstanding rejections and allow the currently pending claims.

Issues Under 35 U.S.C. 103(a)

Claims 1-6 stand rejected under 35 U.S.C. 103(a) as being obvious over Yokogawa et al. (U.S. 2003/0141518) (hereinafter “Yokogawa”) in view of Kashima et al. (JP 07-086162) (hereinafter “Kashima”). Applicants respectfully traverse.

The Examiner asserts that Yokogawa discloses a high electron mobility transistor structure including a heterojunction comprising an InP substrate, an InAlAs layer, an InGaAs layer, an n-InAlAs layer and an InP layer serving as an etch stopping layer. The Examiner further asserts that Yokogawa teaches using MBE and further using source material beams of In, Al, and As to form InAlAs, “which clearly suggests a first step of irradiating beams of at least one group III element and a molecular beam of a first group V element to form a first semiconductor layer.” Additionally, the Examiner asserts that Yokogawa teaches forming an InP layer epitaxially, “which clearly suggests supplying source beams of a group III element... and a group (V) element...”

The Examiner acknowledges that Yokogawa fails to teach or suggest a step of stopping the irradiation of the molecular beams and halting growth for a period of time until the remaining molecular beam intensity of the first group V element is reduced to be in the range of 0.01 to 0.1 of

that in the first step. The Examiner relies on Kashima to support a proposition that it would have been obvious to stop the flow of reactants for a sufficient period of time "to control the deposition of superfluous group V or Group III elements in the heterointerface."

Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness. To establish a *prima facie* case of obviousness, the Examiner must make the factual determinations set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). "[T]he examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a *prima facie* case of unpatentability." *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR Int'l Co. v Teleflex Inc.*, 82 USPQ 2d 1385 (U.S. 2007). There must be a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does. *Id.* The Supreme Court of the United States has recently held that the "teaching, suggestion, motivation test" is a valid test for obviousness, albeit one which cannot be too rigidly applied. *Id.* "[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *Id.* (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

The present invention is directed, *inter alia*, to an epitaxial growth method comprising (a) a first step of irradiating a molecular beam of at least one of group III elements and a molecular beam of a first group V element to form a first compound semiconductor layer; (b) a second step of stopping the irradiation of the molecular beam of the group III element and the molecular beam of the first group V element and halting growth for a period of time until a remaining

molecular beam intensity of the first group V element is reduced to be in the range of 0.01 to 0.1 of that in the first step; and (c) a third step of irradiating a molecular beam of at least one of the group III elements to form an etch stopper layer, wherein the semiconductor thin film comprises a high electron mobility transistor structure (see, e.g., claims 1 and 2). Applicants submit that the references of record do not teach or suggest a method as claimed.

As correctly acknowledged by the Examiner, Yokogawa fails to teach or suggest a step of stopping the irradiation of the molecular beams and halting growth for a period of time until the remaining molecular beam intensity of the first group V element is reduced to be in the range of 0.01 to 0.1 of that in the first step. Yokogawa discloses a semiconductor device comprising InAlAs, InGaAs, N-InAlAs layers and an InP etch stopper layer provided above an InP substrate as an HEMT structure having a heterojunction. However, the reference is silent as to adjusting the opening-closing shutter sequence of the raw material supplying source. Accordingly, this reference cannot possibly teach or suggest lowering the selectivity when the InP layer is contaminated by Group V elements. Contrary to the Examiner's assertion, Kashima fails to cure the deficiencies of Yokogawa.

Kashima discloses a hetero structure between an InGaAs layer and an InP layer in a device comprising a superlattice structure, such as an HBT. However, the InP layer described in this reference is not an etch stopper layer, but is rather part of the hetero structure. Further, Kashima is also silent as to the selectivity being lowered when the InP layer is contaminated by Group V elements (or as to what a person skilled in the art would do to cure this problem).

As shown in FIGS. 1, 2, 4 and 5 of Kashima, the supply sequence of Va or arsine indicates that the supply thereof is continued even after the supply of Group IIIa elements or

In/Ga (which corresponds to t1 in FIG. 1, and 2 seconds in FIGS. 2, 4 and 5) is stopped. This means that Group V elements, which cause the contamination of the etch stopper layer, continue to be supplied for an even longer period of time (by themselves). Accordingly, even though Kashima teaches a “downtime” (which lasts for t2 in FIG. 1, and 24 seconds in FIGS. 2, 4 and 5), it does not follow that the remaining molecular beam intensity is reduced to 0.1 or less in Kashima.

Further, the Group V elements supplied by themselves are likely to be attached to the substrate surface and inside portion of the apparatus, which would also cause contamination in the etch stopper layer during subsequent processing. Moreover, FIG. 5 of Kashima shows that the In supply is restarted before the supply of phosphine is started, which would evidently make the etch stopper layer contaminated by the Group V element, because the remaining arsine is to be reacted with In. As such, Kashima does not in any way teach or suggest the claimed step of stopping the irradiation of the molecular beams of Group III and first Group V elements. Accordingly, even if the references were combinable in the manner suggested by the Examiner, such combination would still fail to render obvious the present invention, or teach or suggest the advantageous effects obtained therefrom.

The Examiner asserts, in Response to Applicants' previous arguments, that Applicants have failed to show the criticality of the endpoint of 0.01. Applicants note, however, that as clearly shown in FIGS. 4 and 5 of the present application, it would take at least 20 seconds for the remaining molecular beam intensities to be reduced to less than 0.01. When the growth layer (Si-doped InAlAs layer in this case) is left for such a long time without being irradiated by any molecular beam, As escapes from the layer, which increases the risk of the film composition

being altered. This in turn deteriorates the device characteristics. One skilled in the art would easily notice such risk from the disclosure of FIGS. 4 and 5.

Moreover, as previously discussed, the claimed endpoint of "0.1" results in a desirable etching resistance and manufacturing efficiency to be "compatible" and further results in formation of an etch stopper layer with high selectivity, and with high efficiency.

Evidently, the cited references, alone or in combination, fail to teach or suggest a method as claimed. For this reason alone, this rejection is improper and should be withdrawn. Moreover, as previously discussed, the present invention achieves superior and unexpected results, which rebuts any *prima facie* case of obviousness arguably established by the Examiner.

Reconsideration and withdrawal of this rejection are respectfully requested.

Conclusion

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding rejections and objections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Vanessa Perez-Ramos, Reg. No. 61,158 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.17; particularly, extension of time fees.

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Respectfully submitted,

By


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